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ABSTRACT

Four hundred forty six female university students who had completed at least five courses were tested for self-schemas in math/science ability. One hundred eighty-four of the women had taken or were taking more than the required one basic math or science course. It was found that 35.0% of the women in the sample could be classified as having a positive self-schema for math/science ability, while only 14.1% could be classified as having a negative self-schema for this ability. Women were more likely to be positive schematic for math/science ability if they had taken or were taking math or science courses. Both the finding of such a small proportion of women classified as negative schematic and the subjects' responses to open-ended questions about the reasons for their course choices suggest that many university women avoid math and science courses not because of a sense of inferiority with respect to their abilities in these areas, but simply because of a lack of interest. The problem of women's avoidance of math and science courses may well lie less with the women themselves than with the presentation of math and science to them. (Author)

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Math/Science Self-schemas and Curriculum Choices Among Univeristy Women

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Paper presented at the annual convention of the American Psychological Association, Toronto, August, 1984

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Math/science Self-schemas and Curriculum Choices Among University Women

Four hundred ~~and~~ forty six female university students who had completed at least five courses were tested for self-schemas in math/science ability. One hundred ~~and~~ eighty-four of the women had taken or were taking more than the required one basic math or science course. It was found that 35.0% of the women in the sample could be classified as having a positive self-schema for math/science ability, while only 14.1% could be classified as having a negative self-schema for this ability. Women were more likely to be positive schematic for math/science ability if they had taken or were taking math or science courses. Both the finding of such a small proportion of women classified as negative schematic and the subjects' responses to open-ended questions about the reasons for their course choices suggest that many university women avoid math and science courses not because of a sense of inferiority with respect to their abilities in these areas, but simply because of a lack of interest. The problem of women's avoidance of math and science courses may well lie less with the women themselves than with the presentation of math and science to them.

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Math/science Self-schemas and Curriculum Choices Among University Women

The decision to engage in or to avoid endeavors that involve mathematics and science is a gender-related behavior that urgently requires further study. Women students' absence from math and science courses is a well-documented phenomenon, which has aroused considerable concern in North America, not only because of the low numbers of women in math and science careers, but also because math and science are prerequisites for entering so many fields (Ernst, 1974; Fennema & Sherman, 1976; Hollinger, 1983; Science Council of Canada, 1981; Scott, 1981; Sherman, 1982; 1983). The concern has been especially heightened by the emerging importance of computers in virtually all areas of the labor force (Menzies, 1981).

The present study focused on self-schemas for math/science ability among female university students. The self-schema construct, the existence of networks of association used by the individual to organize and process self-relevant information, has received increasing attention from psychologists in recent years (Bem, 1981; Markus, 1977; Markus, Crane, Berstein, & Siladi, 1982; Markus & Smith, 1980; Miller, 1984; Rogers, Kuiper & Kirker, 1977). Theoretically, self-schemas concerning abilities, aptitudes and interests could mediate students' selection of courses, the learning of important concepts or skills, and processing of information relevant to career preparation. The

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present study was designed to examine empirically both the prevalence of positive and negative self-schemas for math/science ability among a sample of university women, and the relationship between such self-schemas and the behavior of choosing to take courses with math and science content.

For a given trait or ability, an individual may be either positive schematic, negative schematic, or aschematic. In the first two cases, the individual considers the relative "amount" of the given trait or ability possessed to be an important part of the self-concept, In the last case, the individual considers the trait or ability irrelevant to her/his self-concept. Thus, a person who is positive schematic for math/science ability would rate herself/himself high on this ability and high level of ability in this area would be an important part of her/his self-concept. A person who is negative schematic for math/science ability would rate herself/himself low on this ability, and this low level of ability would be an important part of her/his self-concept. On the other hand, a person who is aschematic for math/science ability might rate him- or herself low, medium, or high on the ability, but would consider level of ability in this area fairly irrelevant and unimportant to her/his self-concept.

One might reasonably presume that women who avoid math and science courses in university would tend to be either negative schematic or aschematic for this ability, and that those who take math and science courses by choice are more likely to be positive schematic. This is, in fact, an empirical question addressed by

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this study. To date, there have been few investigations of behavior outside the lab which is related to self-schemas. The most interesting aspect of the question, from a practical point of view, involves the categorization of women who avoid math and science courses. The emphasis on concepts such as "math anxiety" (Tobias, 1976) as explanations for women's absence from math and science courses seems to assume that women hold very strong negative self-concepts in this area of ability (i.e. that they seem to be negative schematic). However, it may be that for many women, their level of ability in math or science, whether high or low, is simply irrelevant or unimportant to their view of themselves, and that they view the learning of math and science as irrelevant to their personal goals (i.e. that they are aschematic with respect to math and science ability). Indeed, Hollinger (1983) notes that female students high in mathematical ability may avoid math/science careers because such careers are perceived as stereotypically masculine, with little emphasis on interpersonal, artistic or creative skills; and Sherman (1983) argues that women avoid math and science careers not because of anxiety with respect to ability, but because of sex-role strain and potential conflict between professional and wife/mother roles.

If the relative absence of women from math and science courses is seen as a situation which it would be desirable to change, one aspect of that change would involve women students' own attitudes. Since strategies for increasing the perceived relevance and importance of science and mathematics to female

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students are probably quite different from those required to change negative self-concepts with respect to ability in this area, it would be useful to know how much emphasis to place on each approach. It was the goal of this study to help determine that.

Method

A computer listing of all currently registered female undergraduate students who had completed at least five courses was obtained from a midwestern Canadian university. The list was divided into those who had taken or were taking at least one course in the mathematics, chemistry, physics or biology departments and those who had not. Each group yielded approximately 800 names. The math/science group was further narrowed down to include only those women who had taken more than the required one course in basic science. The resulting list contained about 400 names. For reasons that will not be gone into here, an additional list of 169 women taking physical education courses and not taking math or science was also used. Two hundred names from the math/science list and 300 from the no-math/science list were randomly chosen to be contacted for the study, as well as all names from the physical education list. These people were contacted first by letter and then by telephone. One hundred and eighty-four women from the math/science list, 213 from the no-math/science list, and 49 from the physical education list agreed to participate in the study.

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Subjects were run in groups of 2 to 10 over a four-week period during the fall semester. In the lab, they completed a series of questionnaires, which included a measure of their self-schema for math/science ability (developed for this study using Markus' 1977 approach), a measure of their confidence in learning mathematics (Fennema & Sherman, 1976), and open-ended questions about their reasons for taking or not taking courses in science and mathematics.

Results

Four eleven-point bipolar items, mixed in with other items, measured a subject's self-schema for math/science ability. Subjects first described themselves on each item and later rated the importance of each of the four to their view of themselves. These 4 items were derived from a pilot test with undergraduate students, using 26 items. A principal components analysis indicated that these 4 items loaded most strongly and uniquely on one factor which consisted of variables relevant to math/science ability. The items and their intercorrelations for the present sample is shown in Table 1.

Insert Table 1 about here

The frequency distribution of responses to the two parts of the four items is shown in Table 2.

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Insert Table 2 about here

Following Markus (1977), subjects were classified as positive schematic if they rated themselves high (8-11) on at least 3 of the 4 items and rated at least the same 3 of 4 items as important (8-11) to their self-view. Conversely, subjects were classified as negative schematic if they rated themselves low (1-4) on at least 3 of the 4 items and rated at least the same 3 of 4 items as important to their self-view. Subjects were classed as aschematic if, regardless of their self-description on the 4 items, they rated at least 3 of the 4 items as unimportant (1-4) to their self-view.

Using the above stringent criteria, 78 or 17.5% of the sample of 446 women could be classified as clearly positive schematic for math/science/science ability, 74 or 16.6% could be classified as aschematic, and only 3 or 0.7% could be classified as negative schematic. When the criteria were loosened to include respondents who were rated themselves high in ability and importance on at least 2 of the 4 items and no lower than neutral on the other two, the number of positive schematics rose to 96 or 21.5%. A parallel easing of the the criteria for negative schematics brought their number only up to 5, or 1.1%. Thus, the number of women in the sample demonstrating negative self-schemas for math/science ability was surprisingly small, especially given the fact that a

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large proportion of the sample was made up of people not taking math and science. Eventually, the criteria for inclusion in the three schena levels was loosened still further, in order to make use of as much of the sample as possible in further analyses. The positive schematic group was defined as all subjects rating themselves higher than one-half of a standard deviation above the mean on at least 2 of the 4 self-description items, while also rating the importance of at least 2 items higher than the mean. The negative schematic group was defined as all subjects rating themselves lower than one-half of a standard deviation below the mean on at least 2 of the 4 self-description items, while also rating at least 2 items higher than the mean. The aschematic group was defined as all subjects who, regardless of their self-ratings on the self-description items, rated at least 3 of the 4 items lower than one-half of a standard deviation below the mean in terms of importance to their view of themselves. Using these criteria, 156 respondents (35.0%) were categorized as positive schematic, 63 respondents (14.1%) were categorized as negative schematic, and 56 (12.6%) were categorized as aschematic for math/science ability.

Self-schemas were clearly related to course selection. Approximately two-thirds (64.7%) of the women who were classified as positive schematic were from among those who were taking or had taken math and science courses, while only 10.8% of the negative schematics were from this group.

A frequency distribution of scores on the Fennema-Sherman

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Confidence in Learning Mathematics Scale (CLM) for the entire sample is shown in Table 3. A clear relationship was found between self-schema classification and self-efficacy for mathematics, as measured by the CLM. A one-way analysis of

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Insert Table 3 about here

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variance was carried out contrasting the CLM scores of the positive schematic, negative schematic, and aschematic groups. The effect of group was found to be significant, $F(2,272)=133.85$, $p<.0001$, with group differences accounting for 50% of the variance in the CLM scores. The mean scores on the CLM scale were 61.74 for the positive schematic group, 38.25 for the aschematic group, and 33.76 for the negative schematic group.

There was a stronger tendency for the women to rate themselves as high on ability for math and science than to rate that ability as an important part of their self-concept. While 103 of the 446 women rated themselves high on the self-description part of all 4 math/science items, only 56 women rated all 4 as important to their self-view. These findings are underlined by responses to the open-ended questions, in which subjects frequently commented that, while they were quite competent in science and math subjects, they did not like them or found them dull. In fact, an examination of responses to these questions

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shows that the reason most frequently given by women in this sample for avoidance of math and science was lack of interest. On the other hand, the most frequently-mentioned reasons for taking math and science courses were program requirements and interest in the topic. Tables 4 and 5 show the frequency with which various reasons were given for taking or avoiding math and science courses.

Insert Tables 4 and 5 about here

Discussion

The results of this study suggest that the major reason for many college women's avoidance of math and science does not lie in a sense of inferiority with respect to their abilities in these areas, but simply with a lack of interest. It appears quite possible that the problem of women's avoidance of math and science courses lies less with the women themselves than with the presentation of these subjects. While self-confidence in math/science ability is related to being positively schematic for math/science, it is clearly only one aspect of the development of a college woman's sense that her abilities in math and science are relevant and important.

The methodology used for assessing the self-schema, though directly modelled on that which received acceptance through

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Markus' work (Markus, 1977; Markus et. al., 1982; Markus & Smith, 1980) may be vulnerable to the criticism that it is less sensitive to the presence of negative than positive self-schemas. It can be argued that a person who rates herself low in possession of a particular trait or ability is unlikely, on self-presentation grounds, to rate her level of that particular trait or ability as an important part of her self-concept, at least if it is a socially-desirable trait. (The reverse might be true for an undesirable trait. A person might quite conceivably rate herself very low in dishonesty, for example, while rating the fact that she has very little dishonesty as extremely important to her self-concept.) Indeed, for each item used to measure math/science self-schema, there was a significant positive correlation between subjects' self-description on the item and their rating of the importance of that self-description to their self-concept. However, the correlations are far from perfect, and the discrepancies that do exist between the "self-description" and "importance" ratings indicate that the two dimensions are not completely tied to each other.

The college women in this sample were more confident in their mathematical and scientific ability than the negative stereotypes surrounding women in mathematics and science might predict. It remains to be seen whether future changes in the way these disciplines are viewed will have an impact on the degree to which women regard their abilities in these areas to be relevant and important to their personal goals.

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Author Notes

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Table 1

Intercorrelations of items used to measure self-schema formath/science ability[1]

	Mathematically Inclined (A)	Good with Numbers (A)	Good at Abstract Reasoning (A)	Enjoy Learning About Science (A)	Importance of Mathematical Inclination (B)	Importance of Number Ability (B)	Importance of Abstract Reasoning (B)	Importance of Enjoy Learning About Science (B)
(A) Mathematically Inclined	1.000	.774	.391	.409	.417	.324	.094*	.227
(A) Good with Numbers		1.000	.337	.319	.358	.318	.069**	.203
(A) Good at Abstract Reasoning			1.000	.308	.391	.108*	.323	.132*
(A) Enjoy Learning About Science				1.000	.324	.273	.120*	.600
(B) Importance of Mathematical Inclination					1.000	.730	.404	.441
(B) Importance of Number Ability						1.000	.344	.488
(B) Importance of Abstract Reasoning							1.000	.275
(B) Importance of Enjoy Learning About Science								1.000

$p < .001$ unless otherwise noted
* $p < .05$
** $p > .05$

[1] Items marked (A) measured the degree to which respondents rated themselves as possessing the quality in question. Items marked (B) measured the degree to which respondents rated their level of the quality in question as important to their self-concept.

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Table 2

Frequency distribution of responses to the

math/science self-schema items (n=446)

Item	Score 1 Low	2	3	4	5	6	7	8	9	10	11 High
Mathematically Inclined	5.6%	9.2%	10.3%	8.5%	4.0%	9.9%	8.3%	13.5%	12.6%	12.6%	5.6%
Good with Numbers	2.0%	6.7%	6.9%	7.2%	4.7%	10.3%	5.8%	9.9%	15.7%	15.7%	11.0%
Good at Abstract Reasoning	0.2%	2.2%	5.6%	4.7%	6.1%	12.6%	13.5%	17.7%	18.2%	15.0%	4.0%
Enjoy Learning About Science	2.5%	4.9%	4.9%	5.6%	4.7%	13.2%	8.5%	11.0%	12.6%	13.7%	18.4%
Importance to Self-concept of "Mathematically Inclined" level	5.8%	9.4%	8.1%	7.2%	7.4%	6.6%	13.0%	11.4%	9.4%	6.9%	4.7%
Importance to Self-concept of "Good with Numbers" level	4.3%	7.2%	8.3%	9.4%	7.4%	14.8%	12.8%	14.3%	10.3%	7.1%	3.8%
Importance to Self-concept of "Good at Abstract Reasoning" level	3.1%	5.6%	7.2%	6.5%	4.3%	13.9%	15.2%	16.1%	12.8%	11.7%	3.4%
Importance to Self-concept of "Enjoy Learning About Science" level	6.3%	9.0%	12.6%	8.5%	5.8%	13.0%	11.0%	11.2%	9.0%	7.6%	5.8%

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Table 3

Frequency Distribution of Scores on the Fennema-Sherman Confidence in Learning Mathematics Scale (CLM)*

Range	Frequency	Percent of Total
12 - 22	40	9.09%
23 - 32	54	12.27%
33 - 42	70	15.91%
43 - 52	63	14.32%
53 - 62	73	16.59%
63 - 72	140	31.82%
Total	440	

* The CLM consists of 12 items on which respondents indicate level of agreement. Each item was followed by six response alternatives ranging from Strongly agree to Strongly disagree. A high score indicates strong confidence in one's ability to learn and perform on mathematical tasks.

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Table 4

Reasons given by women to explain why they were studying mathematics or science[1] (n=279)[2]

Reason	Percent of Sample
Program Requirement	57.3%
Interest/Liking	50.5%
Useful/Relevant	13.9%
Ability/Done well in past	13.9%
Expect to do well	1.1%
Curious about topic	1.4%

[1] When more than one reason was listed, all reasons were coded. Therefore, the percentages do not add to 100.

[2] Although only 184 subjects were obtained from the list of students who were taking or had taken math or science courses, 279 answered in the affirmative to the question of whether they were taking or had taken such courses. We believe the extra subjects were responding re courses taken in pre-university years.

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Table 5

Reasons given by women to explain why they were not studying mathematics or science[1] (n=165)

Reason	Percent of Sample
Fear it is too difficult	9.1%
Have had previous problems	17.6%
No interest	56.9%
No background	13.3%
Not relevant or required	23.6%
No time	2.4%

[1] When more than one reason was listed, all reasons were coded. Therefore, the percentages do not add to 100.

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